

Rule
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--21.19.

A method for determining a precompensated pattern of exposure doses of an electron beam required per pattern position to obtain a desired pattern in a coating on a substrate, the method comprising the steps of:

determining a smearing function of the electron beam; and

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determining a precompensated pattern with the smearing function and a desired pattern, wherein the determination is performed such that electron beam exposure doses contain almost exclusively positive values and that the electron beam exposure doses are smooth relative to each other, wherein the step of determining the precompensated pattern comprises the steps of:

a) estimating a regularization parameter;

b) determining a precompensated pattern with all pattern points of the desired pattern with the exception of a determined pattern point;

c) smearing the precompensated pattern again with the smearing function in order to predict the dose of the determined pattern point;

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d) repeating steps b) and c) for each pattern point;

e) repeating steps a) to d) with an adapted regularization parameter until a final value of a regularization parameter is obtained; and

f) determining the precompensated pattern with the final value of the regularization parameter.

20.
22. The method as claimed in claim 19, wherein step b) is determined utilizing the following iterative equation:

$$d^{(\ell)} = d^{(\ell-1)} + (K^v K + \lambda B(D))^{-1} K^v r^{(\ell-1)} \quad r^{(\ell)} = a - K d^{(\ell)}$$

5 with $d^{(0)} = 0$ and $r^{(0)} = a$

wherein a is a vector with the doses of the desired pattern as elements, d is a vector with the exposure doses of the precompensated pattern, K is the smearing function in matrix form, K^v is the Hermitian conjugate of the smearing function K , B is an operator and λ a regularization parameter.

20.
21. The method as claimed in claim 20, wherein the operator B is defined as follows:

$$B(D) = \sum_i \left(\frac{d_i}{d_{tot}} \right) \ln \left(\frac{d_i}{d_{tot}} \right)$$

5 in which the summation takes place over all pattern points, d_i is the i^{th} element of the vector d , and d_{tot} represents the summation over all elements of the vector d .

19.
~~22.~~ 24. The method as claimed in claim ~~21~~, wherein the final value of the regularization parameter in step e) is the regularization parameter

$$\frac{1}{N} \sum_{k=1}^N \left(a_k - [Kd_k(\lambda)]_k \right)^2$$

wherein N is the total number of pattern points, a is a vector with the doses of the desired pattern as elements, d is a vector with the exposure doses of the precompensated pattern and K is the smearing function in matrix form.

19.
~~23.~~ 25. The method as claimed in claim ~~21~~, wherein the final value of the regularization parameter in step e) is the minimal regularization parameter

$$\frac{1}{N} \sum_{k=1}^N \left(a_k - [Kd^k(\lambda)]_k \right)^2 W_{kk}(\lambda)$$

wherein N is the total number of pattern points, a is a vector with the doses of the desired pattern as elements, d is a vector with the exposure doses of the precompensated pattern, K is the smearing function in matrix form and w_{kk} is defined as:

$$w_{kk}(\lambda) = \left[\frac{1 - a_{kk}(\lambda)}{1 - \frac{1}{N} \sum_{j=1}^N a_{jj}(\lambda)} \right]^2$$

with a_{kk} the elements of the matrix $A = K(K^T K + \lambda L(D)^T L(D))^{-1} K^T$ and L the Laplace operator.

24. 26. The method as claimed in claim 19, wherein after step e) the step is performed of training a neural network using one or more desired first patterns and the associated precompensated patterns.

25. 27. The method as claimed in claim 24, wherein the precompensated pattern associated with a second desired pattern can be determined with the trained neural network.

26. 28. The method as claimed in claim 25, wherein the first desired pattern is a relatively simple training pattern and the second desired pattern is a partial pattern of an integrated circuit.

27. ~~29.~~ The method as claimed in claim ~~28~~²⁶, wherein two or more partial patterns can be combined into a composite pattern of the integrated circuit.

28. ~~30.~~ The method as claimed in claim ~~28~~²⁴, wherein the neural network is a radial base function network.

29. ~~31.~~ The method as claimed in claim ~~26~~²⁴, wherein the neural network is implemented in hardware.

30. ~~32.~~ The method as claimed in claim ~~31~~²⁹, wherein the neural network is implemented in analog hardware.

31. ~~33.~~ The method as claimed in claim ~~21~~¹⁹, wherein the smearing function is made up of at least two Gaussian functions.

32. ~~34.~~ The method as claimed in claim ~~33~~³¹, wherein an exponential function is added to the smearing function.

33. ~~35.~~ The method as claimed in claim ~~33~~³¹, wherein the parameters of the Gaussian functions can be determined using statistical simulations.

34. ~~36.~~³¹ The method as claimed in claim ~~33~~, wherein the parameters of the Gaussian functions can be determined by measurements.

35. ~~37.~~ A device for determining the exposure dose of an electron beam required per pattern position to obtain a desired pattern in a coating on a substrate, comprising electronic circuit means for implementing a neural network having weighting factors determined by training the neural network by using as inputs one or more desired patterns and corresponding precompensation patterns determined by the steps of:

- a) estimating a regularization parameter;
- b) determining a precompensated pattern with all pattern points of the desired pattern with the exception of a determined pattern point;
- c) smearing the precompensated pattern again with the smearing function in order to predict the dose of the determined pattern point;
- d) repeating steps b) and c) for each pattern point;
- e) repeating steps a) to d) with adapted regularization parameter until a final value of a regularization parameter is obtained; and
- f) determining the precompensated pattern with the final value of the regularization parameter.--

IN THE ABSTRACT:

After the claims, please insert a page containing the Abstract Of The Disclosure, which is attached hereto as a separately typed page.